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THE PROGRESS OF BRITISH WARSHIPS' DESIGN.

BY ADMIRAL P. H. COLOMB, R. N.

THE advice to buy in the cheapest market and sell in the dearest is not commonly tendered to those authorities who have ultimately to determine the type of the warships. And yet I am not clear that it is bad advice even to them. What they have to buy is naval force, and what they have to sell is the result of force should war send them to market. All the adverse criticisms that can possibly be offered on the type, armament, speed, and endurance of any warship only result in asserting that more force for sale could be bought with the money. No doubt the fact is little present to the minds of such hostile critics as are in the habit of straining at naval gnats and swallowing naval camels; but if it were present in a greater degree the criticisms pronounced would generally be sounder. But as we stand, in the middle of all the controversies as to whether the ships are too large or too small, whether the battleships and cruisers are properly proportioned in number, whether there is a sufficiency of end-on fire, or whether any ship is fast enough, it requires a distinct intellectual effort to realize that we are discussing economy measured in money.

The British purse is so long, and when our people are hot on any subject so easy to get at, that we are sometimes disinclined to look at alternative articles in the buying market. The sweep of invention in the matter of warship design is then in a measure turned in on itself, and can only modify the models it finds already adopted.

The alternative thesis in design is a necessity in the question of cost. If so many ships of such a design represent so much force and cost so much money, will so many other ships of such

another design represent the same force for less money ? That is the real question always before the naval architect, but it is much less pressing on him in times of naval boom than when the Chancellor of the Exchequer keeps his pockets buttoned. In times of boom the cry is for a full supply of existing designs ; it is when the cold fit is on that alternatives receive attention.

But alternatives are constantly offered to the naval architect which do not admit of choice. There are inventions to improve the power of the gun, and the armor for resisting its projectiles ; increases in the range, accuracy, and charge of the torpedo, and means for reducing the waste in burning the pound of coal so as to get more propulsive power out of it. To be improvements these inventions must yield an increase in result without a proportionate increase in the weight, or perhaps the space, that they claim in any design. Once this is proved by experiment the designer has no choice ; he must adopt the new inventions or be left behind in the race.

The alternatives only offer a choice when it is considered how the economies offered by invention shall be applied. Shall all design remain as it is, and shall we increase the gun-power, armor resistance, torpedo power, speed, and coal endurance in the proportions allowed by invention ? Or shall gun-power be varied, increasing numbers and decreasing individual power ? Or will it be desirable to reconsider the gun's position in ships as a tactical question ? Or shall the gun remain in power and place as it was, in order to add to some other element ? Shall armor cover greater areas of side with the old resistance ? Or shall the old areas and resistance be maintained in order to put the weight saved into speed, or coal endurance, or gun-power ? Shall coal endurance yield to speed, or speed to coal endurance ? Or shall both remain so that armor resistance and gun-power may be increased ? This great list of alternatives comes before the naval architect as soon as it is decided to adopt any of the improvements described, and the real interest in the problem is the economy of the choice.

But the designer's difficulty lies in the fact that, as far as the adoption of any such improvement goes, he can fully verify his position by experiment in peace time ; while until the experiment of war overtakes him he can seldom verify the wisdom of his alternative choices. But it is even worse than that, for he

must build and equip by the light of an opinion which is continually changing, which will lead him on in certain directions, and then turn around on him and denounce him. It must be so in the absence of war experiment, but even this will not act with much suddenness.

All warships' design rests on some tactical ideas which are now more or less incompletely thought out, and there is continual action and reaction going on between the tactical idea as creating the concrete design and the concrete design as modifying the tactical idea. This interaction may go on till the experiment of war settles it, perhaps in a way that shows the whole thing to have been a fallacy.

It is scarcely a paradox to say that the French Admiral Bouet-Willamez, writing in 1855, influenced the defeat of the Chinese in 1894, tactical idea acting on design, and design forcing the hand of tactics. The simple story is on this wise. Bouet-Willamez, in 1855, conceived that steam had broken with the old line of battle—a fighting formation in Indian file; and he declared that the line abreast—ships ranged beside one another like a line of soldiers—was the true fighting formation for steam fleets. In the old line of battle, the side of the ship was presented to the enemy, and warships prepared to fight in it were denuded of guns at bow and stern so that the whole strength of their fire was delivered at right angles to the line of keel. If steam fleets were henceforth to fight in line abreast, it followed that they might be denuded of fire at right angles to the line of keel, or at least weakened in that direction, provided their greatest strength was given to fire in the line of keel. Bouet-Willamez reaffirmed his opinion in 1865, and the idea coinciding with that of fighting with the ram rather than with the gun, was much followed up in England. It soon began to affect design, so that a sort of craving for heavy bow fire grew up and increased the more it was yielded to. At length came the "Inflexible," where the power of broadside fire was distinctly sacrificed in order to fully develop fire in the line of keel. Other ships of the same type followed, and any Admiral commanding a group of them must have recognized that their force would be best employed in the line abreast.

The most powerful of the Chinese ships, the "Ting-Yuen" and the "Chen-Yuen," followed in an even more pronounced

manner the tactical idea embodied in the "Inflexible." They could only bring out their full force when fought beside each other in the line abreast. The officer in command of the Chinese fleet was thus forced, as it were, by the designs put into his hands, to make Bouet-Willamez's tactical idea his own. Every one heartily condemns the Chinese tactics, but few understand how they were forced on Admiral Ting by the designs under his command. Still fewer understand that the plan of the battle and the losing side in it were determined in 1855.

Even more than this may be said. The conclusiveness of the Yalu experiment in condemning Bouet-Willamez's tactical idea and all that it led to is like to be lost. I have seen but one published diagram of the battle of the Yalu which shows its tactical significance. That one comes direct from Japan. The English diagrams that I have seen condemn Admiral Ito as a tactician, and exhibit his fleet as offering the highest advantages to the Chinese. The draughtsmen have not understood that the battle of Yalu was the first experiment testing the "Inflexible" design; that it was the first trial of the great action of line-ahead against line-abreast; the first practical condemnation of the idea that broadside fire could be economically sacrificed to right-ahead fire.

Hence, the point of interest so far is to note how in new designs the improvement in guns is being used—whether in strengthening fire in the line of keel, or at right angles to it—whether it tends to make our admirals prepare to fight their fleets as we always used to fight them, in the line ahead, or in the manner first proposed by Admiral Bouet-Willamez.

There is no doubt it is tending, though perhaps slowly, in the direction opposed to Bouet-Willamez's tactical idea. The highest form of compromise was reached in the "Devastation," when she was provided with an armament of four heavy guns, two to fire ahead, and two to fire astern, while all four ranged over a considerable arc on the broadside. That compromise now remains in all our battleships, but gradually the really broadside fire of lighter guns has been added. The repelling of torpedo-boat attack has counselled a numerous very light armament, which, because of its number, must be chiefly disposed on the broadside. For some time past, then, design has embodied these things, and for the present it rests with a heavy, a me-

dium, and a light armament; where broadside force, almost from the nature of the case, advances, the treble armament ignores the views of our ancestors, who may be said to have generally avoided variation in calibre except when they could not help it. There is a further question, therefore, as to whether any tendency to reduction in the variation of calibre is on foot.

Take a late battleship like the "Majestic," and we at once find that the improvement in the gun tends, however indefinitely, toward the older tactical idea. The "Royal Sovereign," her immediate predecessor, provides a heavy bow and stern fire of four 67-ton guns, which exhaust the fifty-second part of her weight. The "Majestic" keeps to the compromise on the four heavy bow and stern guns, but they are only forty-six tons each, and only exhaust the eighty-first part of her weight, yet the improvement in the later gun is such that its fire is by no means weakened in proportion to its weight.

The fire in the line of keel of the "Royal Sovereign" is supplemented by four 6-inch guns of seven tons each, which can also be used as broadside guns; this plan remains in the "Majestic." But as the "Majestic" displaces 14,900 tons to the "Royal Sovereign's" 14,150 tons, and as there is the saving of weight on the heavy end-on fire, the "Majestic" shows a broadside fire of six 6-inch guns on each side, against five on each side carried by the "Royal Sovereign." Coming to the light armament, we find that is the same in number in both ships, twenty-eight. Each carries twelve 3-pounders, but the "Majestic" carries sixteen 12-pounders, against the "Royal Sovereign's" 6-pounders. We see, therefore, that, though the influence of Bonet-Willaumez's tactical idea is not lost in the "Majestic," it is weakened; and also that the calibres of the guns mounted are nearer to the mean in the later ship. The designer has used invention to approach, though not by any vigorous steps, the tactical ideas which rested on the experiments of war.

A leading feature in the "Majestic's" design is to carry the guns higher out of the water than usual, and I suppose we must say that it is Harvey armor which has allowed it. The choice of the designer has been to spread over the side of his ships a mean thickness of armor of the old resisting capacity. Belt armor of 18 inches in the "Royal Sovereign" falls to 9 inches

in the "Majestic." The above-water belting of 5 inches in the "Royal Sovereign" remains 5 inches in the "Majestic," with, of course, increased resisting power. While the heavy guns were protected by 17 inches of armor in the "Royal Sovereign," they take only 14 inches in the "Majestic." In the latter ship the 6-inch broadside guns are not only enclosed in lightly armored citadels like the "Royal Sovereign," but they fight behind heavy broadside plating. The smaller and later ship, the "Renown," discloses the same characteristic changes in guns and armor that are shown in the "Majestic," and any one comparing the drawings in *Brassey's Annual* with an intelligent comprehension of the interactions of tactical ideas and concrete designs may trace the tendency to return to the pattern of the "Achilles," a ship designed before the tactical views of Bouet-Willaumez, combining with the notion of a ram battle, had raised to its full height the demand for the line abreast as the fighting formation, with a powerful bow fire to suit it.

Coming to cruisers, it is useful to compare two of the same displacement, such as the "Australia" of 1885 and the "Eclipse" of 1893, in regard to guns and armor. The tactical idea of an end-on battle—modified very likely by supposing a cruiser to be perpetually in chase or chased—impressed the design of the "Australia" so as to furnish her with bow and stern guns of twenty-two tons, capable, in the terms of the compromise, of being also used on the broadside. Then, out of a total of ten slow-firing six-inch guns, two were arranged to fire right ahead and two right astern, as well as on the broadside. The light armament consisted of six 6-pounders and ten 3-pounders, mostly of necessity disposed upon the broadside.

In the "Eclipse," in part, no doubt, because of the increased power given to the 6-inch gun, and in part, I believe, because of the change in tactical idea, the two 22-ton 9.2-inch guns have disappeared altogether. The right-ahead fire is represented in the newer ship by three 6-inch guns instead of by one 9.2-inch, and two 6-inch guns as in the older ship. The right astern fire in the "Eclipse" is represented by two 6-inch guns only. Although something must be said for the increased power which is got out of the lighter guns, the change must be regarded as a weakening of the former tactical ideal. Further advantage is taken of increased power in the individual gun to substitute in the "Eclipse"

six 4.7-inch guns for the six purely broadside 6-inch guns which were found in the "Australia." Again, the light armament is reduced in number as compared with the "Australia," but it is increased in calibre. The "Eclipse" carries eight 12-pounders and only one 3-pounder; at least six of the 12-pounders being purely broadside guns.

It would seem that in the later ship the whole of the increased power of the gun has not been retained, unless, indeed, it might be found in dependence on increased speed of fire, and ammunition in correspondence therewith. But otherwise the general tendency is what we have seen in the "Majestic." The extremes of calibre are cut off, and a mean uniform calibre is more nearly approached. The preparation for an end-on action in line abreast is probably diminished, and that for a broadside action in line ahead is probably increased.

Passing to the armor, I am surprised to note how strongly we hold to the protective armored deck alone, most of it below water, as in the "Eclipse," in place of the combination of armored side with protective deck, all of it above water, as in the "Australia." Full materials for judging rarely travel outside designer's offices, but I have never considered that the advantages and disadvantages of the two systems have been completely threshed out. I anticipated that Harvey's invention would set the controversy in motion again, but it shows no sign of doing so. I have never been able to see that a ship with only a protective deck is safe from being sunk by the lighter guns without penetration of her armor, whereas a ship with belt armor rising a foot or two above water and closed at top by an armored deck is safe unless the armor is pierced. I know it is held that light guns which do not penetrate the "Australia's" armor might destroy her stability by admitting water in a sea-way above the armored deck. This is true enough if means are not provided to allow the water to flow out as fast as it comes in. Such means are patent to the experience of any one who has served in the small sailing ships of the past. At any rate we find the "Australia" with a 10-inch belt, capped by a 2-inch protective deck, and the "Eclipse" with only a protective deck of $1\frac{1}{2}$ to 3 inches. It is possible that Harvey's invention may have saved weight which has gone elsewhere.

One of the novelties in armoring which makes considerable

progress is the isolation of single guns in small armored citadels. The idea is, of course, to minimize the effects of shell bursting in the ship, but as there is no rose without a thorn, I doubt about the moral effect of such isolation unless the number of officers is very much increased. But at least one fallacy seems to be disappearing. It used to be held that it would be better to have no armor at all than armor which was penetrable. The "Inflexible" again was the embodiment of the proposition, showing an immense side with only a small patch of very thick armor in the middle of it. The truth, of course, is that it is no use firing 12-pounders at a ship clothed with four inches of wrought iron, whereas if there were no armor every 12-pound shell would be effective. The armor limits the effective fire, and that is its sole function.

In propulsion, the great change that is coming is the water-tube boiler, which is but the child of true necessity for using steam at very high pressures. Controversy rages over placing it in two of the largest cruisers. The Admiralty moves so cautiously in the general adoption of improvements that it will be somewhat strange if here they should be in error.

But I am not at all sure of our ground in the elements of propulsion. It is very difficult—more difficult than it used to be—to speak with exactness of speed and coal endurance. Forced draught and induced draught each give an elasticity to horse-power too tempting to the designer. Speed for a time can be reached which would be destructive to the boilers if continued. Every sort of care is taken to keep within the margin, but it is a pity that there should be a margin. It is the same with coal supply and endurance. The steaming powers of the ships are now calculated for a quantity of coal which does not represent any uniformly proportionate part of the total coal capacity, and the data are apt to become a question of account. The "Royal Sovereign's" elements are calculated on a 14,150 tons displacement, with 900 tons of coal on board. So are those of the "Majestic" on a displacement of 14,900 tons. But it is represented that the coal capacity of the "Royal Sovereign" is 1,400 tons and of the "Majestic" 1,800 tons, and thus any real comparison between the ships in these respects fails. In the same way the horse-power of the "Royal Sovereign" is put at 9,000, which increased draught may develop to 11,000.

The "Majestic" has nominally 10,000 horse-power, to develop under forced draught to 12,000. In ordinary speed the "Royal Sovereign" stands for 16 knots, developing under pressure to $17\frac{1}{2}$. The "Majestic" shows $16\frac{1}{2}$ knots for her ordinary speed, but does not exceed under pressure that of the "Royal Sovereign."

In the "Australia" and "Eclipse" we have the same features, the "Eclipse" showing 550 tons to the "Australia's" 750 as normal supply, with an indeterminate capacity to the "Australia's" 900 tons. It is in the one element of speed that the newer design distinctly surpasses the old one, the speeds of the "Eclipse" being $18\frac{1}{2}$ to $19\frac{1}{2}$ knots, while those of the "Australia" are from 17 to $18\frac{1}{2}$ knots.

There are general principles on which an opinion may be pronounced. I cannot but think that the building of unarmored cruisers of displacements approaching even those of battleships is buying in the cheapest market. No nation but Great Britain could afford to throw her money about as she has done on the "Blake" and the "Blenheim," the "Powerful" and the "Terrible." They are simply efforts to "go one better" than certain foreign ships, and it is almost impossible to find a place for them in the economy of war that would not be as well filled by smaller and cheaper ships.

But since I wrote on the future of the torpedo in a former number of this REVIEW, I only become more and more convinced that it is there that we should centre our regards. I cannot look on the "Majestic" as a permanent type when purely torpedo vessels, such as the torpedo-boat destroyers, are growing up beside her. There is a much wider margin of possible improvement before the torpedo vessel than there is before the battleship of present type. Even now an armored torpedo vessel is afloat, and speed here tends to increase, while in the battleship it seems to be stationary. No doubt feeling runs just now against the above-water torpedo, and the torpedo vessel only fires them as yet in that way. But it seems to me that presently the naval mind will spring to the conception that buying in the cheapest market and selling in the dearest demands the development of the torpedo vessel pure and simple as against the battleship.

P. H. COLOMB.